

Site and Facilities

NREL operates in six separate locations; five are near Golden, Colorado, 16 km west of Denver, and one is in Washington, D.C. Table 1 summarizes pertinent information on each site. Activities and staffing at each of these locations are discussed in detail later in this section. In total, NREL occupies 50,934 net square meters (m²) of DOE-owned or leased space. Of this total, 24,184 m² is leased and 26,750 m² is owned by DOE. NREL's locations include:

- a 121-hectare (ha) South Table Mountain (STM) site on and adjoining south Table Mountain
- four leased buildings in the Denver West Office Park (DWOP) within 2.7 km of the STM site
- a 113-ha National Wind Technology Center (NWTC) 32 km north of the STM site
- the Joyce Street Facility (JSF), a leased building approximately 13 km from DWOP
- a small leased facility on West 48th Street in Wheat Ridge, Colorado
- leased office space in Washington, D.C.

Table 1. NREL Sites as of September 1996

Site Name	Site Abbrev.	Area (hectares)	Number of Major Buildings (more than 850 m ² each)	Total Occupiable Square Meters of Buildings	Status	Number of Occupants	Distance from STM Site (km)
South Table Mountain*	STM	121 [†]	5	23,534	Owned	305	---
National Wind Technology Center	NWTC	113	2	3,217	Owned	70	32.0
Denver West Office Park	DWOP	na	4	17,818	Leased	601	2.7
Joyce Street Facility	JSF	na	1	5,203	Leased	0	13.0
48th Street Facility	48th	na	0	465	Leased	0	10.0
Washington, D.C.	WDC	na	0	600	Leased	22	---

* Only about one-third of the site can be developed

NREL has had a roller-coaster history in funding and personnel, an important point in understanding NREL's site development to date and its plans (see graph, page 6-23). Beginning in FY 1990, NREL entered another growth cycle, with FY 1993 funding of \$180 million and staffing of 858. With on-site contractors and unpaid students, the total NREL headcount for FY 1993 was 980. NREL's funding grew to \$215 million in FY 1994 and peaked at \$250 million in FY 1995 before the reductions of FY 1996 dropped Laboratory funding to \$183 million. NREL staffing levels followed its funding profile with 962 staff members in FY 1994, peaking at 967 in mid-FY 1995, and dropping to 702 in FY 1996. Total headcount, including contractors and unpaid students, equaled 1103 in FY 1994, peaked at 1258 in mid-FY 1995, and declined to 922 in FY 1996.

NREL also provided the needed office space for DOE's Golden Field Office (GO), reaching a total of almost 75, including staff and contractors in FY 1995. During FY 1996, DOE's Denver Support Office (DSO), consisting of about 22 staff members, co-located with the GO staff bringing the total DOE staffing level to slightly over 100 with facilities available to house up to 104. Effective July 1, 1996, DOE contracted, through GSA, to lease its space directly from Denver West Office Park (DWOP) thus reducing NREL's leased space by 2,111 square meters.

Since its opening, NREL's support to DOE has grown substantially in terms of both in-house staff and subcontracted projects with industry, but NREL's permanent support and research facilities have not kept pace. As can be seen from Table 1, half of NREL's current occupiable space is not owned by DOE but instead is leased. Operating in leased facilities, especially for R&D activities, has significant drawbacks discussed below.

Existing Conditions and Facilities

South Table Mountain Site

The South Table Mountain (STM) site, owned by DOE, is NREL's primary site for large research buildings, field testing, concept development, and full-scale development activities. It is located in a mixed-use area surrounded by residential, commercial, and open space areas, 13.5 km west of downtown Denver and 6.4 km east-southeast of the central business district of the city of Golden. The STM site is only partially developed (27%), currently supporting three minor and two major research buildings and several supporting structures, with a combined area of 23,534 m².

Factors Affecting STM Site Development

The STM site is located on the flank of a mesa, which limits site development. (See map, page 6-3.) Although the mesa presents many unique design opportunities, a significant portion of the STM site has steep, erosive slopes; rock outcrops; deep drainage channels; and other physical constraints. Based on a site density analysis, the STM site will accommodate 1650 people if fully developed.

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NREL has completed an assessment of the west end of the STM to recover usable land area using an aggressive water management scheme.

The topography naturally divides the site into three areas of about 40 ha each—the mesa top, slope,

and toe. The mesa toe is the only area suitable for large-scale development. The east end of the mesa toe is the area best suited for major research and laboratory buildings because sufficiently flat land is available for buildings, parking, and transportation access. At the west end of the mesa toe, a narrow, 7-ha strip of land running east to west is used for field-testing functions such as the outdoor testing of equipment, concept development activities, and pilot plants, as well as storage and warehousing.

Numerous environmental factors make this more difficult to develop than the east end, and limit the size and placement of buildings. The mesa slope has a grade greater than 20%, which prohibits construction, and the slope is unstable when disturbed. The rockfall zone, steep slopes, and major drainage ways will be preserved as open space. The mesa top has poor soil conditions and a shallow depth to bedrock; no water, sewer, or natural gas service; and limited electrical service. Access is difficult. Only low-impact activities that are performed in relatively low, unobtrusive buildings and involve a minimum number of people should be located on the mesa top.

The entire STM site is very visible to the surrounding community for several kilometers; NREL is sensitive to the concerns of residential neighbors about minimizing the visual impact of research activities on the mesa top, and the appearance of all research facilities. NREL's neighbors have

expressed a desire to continue to use the STM site as open space for hiking and wildlife watching. NREL and DOE have noted their concerns at several public meetings and have agreed that the site will remain open as long as the interests and property of the government are protected and the safety of NREL staff members and visitors is maintained.

The Stevinson family (the landlord of the Denver West Office Park) began construction of its Planned Residential Development in FY 1996 on land it owns adjacent to the STM to the east. During FY 1995 and FY 1996, three major facilities for three major corporations, totaling almost 23,226 square meters, have been added to the DWOP commercial complex adjacent to the STM. In addition, a major shopping center started construction in FY 1997 adjacent to another portion of the DWOP.

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STM Facilities

At the STM site, DOE owns 23,534 m² of space; the largest building is the Solar Energy Research Facility (SERF) (9,599 m²), completed in FY 1993, which provides low-bay laboratories and associated office space for basic research and photovoltaics. The Field Test Laboratory Building (FTLB) (7,938 m²), built in 1985, houses extensive high-bay areas and is used as a multi-purpose facility with low-bay laboratories, shipping, receiving, and stockroom facilities, and some high-bay research areas. The Alternative Fuels User Facility (AFUF) (2,482 m²), completed in FY 1994, absorbed the Biotechnology Research Facility (BTRF) and contains laboratory and office space as well as the Process Development Unit (PDU) pilot plant.

The Outdoor Test Facility (OTF) (860 m²), completed in FY 1995, provides office space and indoor laboratory facilities in support of the outdoor solar array test area adjacent to the OTF to the east. The Thermal Test Facility (TTF) (915 m²), completed in FY 1996, provides open bay and roof-top test areas as well as work areas for technicians and visitors researching building thermal systems. The Visitor Center (VC) (573 m²) at the entrance to the site provides technology displays and meeting space for visitors from the general public who stop at NREL to find out more about its areas of research. The Site Entrance Building (SEB) (72 m²), directly south of the Visitors Center, houses personnel providing security for entrance to the site as well as visitor badging, overall site security, and fire alarm monitoring. Construction began in FY 1996 on the Shipping and Receiving Facility (1282 m²), located at the west end of the STM site, which is ready for occupancy in 2Q FY 1997.

Current STM Construction Projects

Design of the multi-year FTLB renovation and expansion program (see page 6-15) also began in FY 1996; construction will begin in FY 1997. In addition to HVAC and electrical system upgrades and a 410-m² second floor in a high bay area for building seven new wet mid-bay laboratories, plans call for constructing a new office pod/support area (2000 m²) at the rear of the current facility and a 900-m² second floor in a high bay area for future buildout of 9 new dry laboratories and office/support are with completion scheduled for FY 1998. With the approval of the funding request in FY 1998, the remaining buildout of the laboratory space (1120 m²) and the renovation of current laboratory space in the FTLB are planned for completion in FY 1999.

In FY 1996, a Geothermal Energy Conversion facility (232 m²), was contracted to be built on the STM mesa top. This facility will be used to test and evaluate advanced heat and mass transfer processes encountered in binary geothermal power plants. Various heat transfer cycles, working fluids, and some equipment modules will be evaluated. Construction will be completed on this facility in 2Q FY 1997.

The Alternative Fuels Program is planning an expansion to the AFUF (929 m²) which is in conceptual design. The expansion consists of a three-floor extension of a south facing wall which will provide additional space to expand existing experiments as well as house future experiments. Construction is envisioned to begin 2Q FY 1998 with completion during 1Q FY 1999.

STM Utilities and Communications

At the STM site, the existing overhead 13.2-kilovolt (kV) electrical distribution system has a single point of metering by the electric utility Public Service Company of Colorado (PSCo). The PSCo line enters the site from the west end of Denver West Parkway and the single point metering is located at the center of the site on the south side of Denver West Parkway in front of the FTLB.

The STM site now has an underground 13.2-kV high-voltage distribution system that has been configured into three loops to provide the high voltage to the various STM site buildings. NREL has ownership of this underground distribution system and the transformers at each of the STM site buildings. The capacity of this loop system has been designed to accommodate NREL's needs for the foreseeable future. NREL is responsible for maintaining the equipment.

PSCo also supplies natural gas to the site. The capacity of the lines is adequate to meet future proposed buildings at the site. Public hearings are underway in which PSCo is requesting a permit to install a proposed 20-inch, high-pressure natural gas pipeline running north-south from Arvada to Lakewood. The proposed routing runs through the STM site between the FTLB and OTF. NREL and DOE/GO are in discussions with PSCo regarding this matter.

The Consolidated Mutual Water Company provides water and the Pleasant View Water and Sanitation District provides sewer service. The sewer system capacity is adequate for the

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current buildings and the buildings requested through FY 1998. However, modifications will be needed in the sewer system to accommodate growth beyond these buildings. The water system is adequate for the foreseeable future.

U S West provides telephone and electronic communications for the STM, DWOP, and other sites. The current communications system at the STM site is considered adequate; NREL is increasing the capacity of this system as required to meet growing needs. NREL is phasing out some of the current analog technology and replacing it with digital technology. During the construction of the 13.2-kV underground distribution system, two 5-inch communications conduits were installed along with the power distribution system. These conduits are routed along Denver West Parkway proceeding to the west end of the site.

In early FY 1997 NREL completed construction of a new central thermal plant (708 m²) behind the FTLB. This plant supplies hot and chilled water to facilities west of the FTLB for heating and cooling. The system will reduce operating labor and maintenance by eliminating several smaller heating and cooling plants. The plant is designed to be able to expand to twice its current thermal capacity to accommodate future facility construction.

STM Transportation

Denver West Parkway provides the main access to the STM site and extends across the southern boundary of the site. Interstate-70 (I-70), a six-lane freeway with a full diamond interchange (two on-ramps, two off-ramps) at Denver West Marriott Boulevard, provides access to the STM site from the Denver metropolitan area. Development of the STM site, including the completion of the facilities currently under construction as well as the Stevinson's DWOP construction projects, will substantially increase area traffic. Due to concerns of exceeding the capacity of the I-70 Denver West interchange, DWOP, NREL and DOE representatives worked with local government officials and the Colorado Department of Transportation to build a 6-lane bridge over I-70, increasing the interchange capacity. As NREL staff members are moved to the STM site, circulation issues (both pedestrian and automotive) will be addressed to ensure adequate safety.

Most of the land at the NWTC has been developed for the outdoor field testing of wind turbines.

National Wind Technology Center

The NWTC is a satellite location for NREL, located in a relatively isolated area adjacent to DOE's Rocky Flats Plant. Most of the land at the NWTC has been developed for the outdoor field testing of wind turbines. Although the land is basically flat and accessible, the absence of water, gas, and sewer service presents a challenge for large-scale development. NREL has not yet performed a site density analysis. An Environmental Assessment is currently underway.

The previous landlord of this site was the DOE Rocky Flats Plant; the site was transferred to NREL in 1993. No radiological operations were conducted on this site, and there are no radiological contamination issues at the site as verified by groundwater sampling and air monitoring activities

over several years. Also, the site is hydrologically upslope and upwind of the Rocky Flats Plant. A local aggregate mining company, owner of the subsurface mineral rights on the site, is interested in extending its existing mining operations at the corner of the NWTC site onto the site itself. NREL and DOE representatives have held discussions with the aggregate company to reach a satisfactory agreement that will ensure NREL's unimpeded development of the site.

NWTC Facilities and Communications

NREL currently occupies 3217 m² of space at NWTC. The largest facility is Building 251, a 2007-m² facility, which was renovated and occupied in late FY 1994. This facility provides office and laboratory space to house 60 people in the wind energy program. The Industrial Users Facility (IUF) (981 m²) was completed in late FY 1996. It provides laboratories and office space for 14 people consisting of NREL staff and industrial users. The NWTC also includes Building 252, a remote test facility laboratory (229 m²). Phone and communications at the NWTC site are currently being provided through U S West. The current communications system at the NWTC site is not adequate; the upgrade of this system is in progress.

Current NWTC Construction Projects

An NWTC infrastructure project consisting of primary road paving and upgrading the electrical feed from PSCo into the site is planned for completion in FY 1997. The Wind Program is currently planning a new Dynamometer and Spin Test Facility (DSTF) (279 m²); the conceptual design is finished. The facility will provide contract testing of industrial customer's prototype wind-turbine designs. It is scheduled to start construction in 1Q, FY 1998 with completion in 3Q, FY 1998.

NWTC Utilities and Transportation

At the NWTC, PSCo supplies the existing 13.2-kV high voltage to the main switchgear containing a split bus configuration. The split bus feeds two main distribution circuit breakers. One main circuit breaker feeds the 13.2 kV to the site buildings while the other circuit breaker feeds the turbine 13.2-kV distribution system. The turbine distribution system is connected in a paralleling configuration with PSCo. A requirement of this paralleling configuration is that the turbine circuit breaker is de-energized whenever there is a disturbance on the PSCo line. This is the PSCo standard safety measure for co-generation or system paralleling to prevent the wind turbines from putting power into the PSCo line while work is being performed. The 13.2-kV electrical distribution system to the testing sites has been recently upgraded. NREL has ownership of this underground distribution system and the transformers at each of the site buildings and test sites. NREL is responsible for maintaining the equipment.

Each test site has been upgraded to accommodate the program requirements for its intended usage. There is no natural gas service or primary sewer system at the site. The sewage system consists of a septic tank and leach field system for Building 251 and the IUF. A commercial firm pumps the septic tank and disposes of the waste on an as-needed basis. Bottled water is provided at the site for drinking water. The existing poor quality well is being abandoned in accordance with state requirements. Domestic water is held in two tanks with a capacity of 64,345 liters. Fire water is stored in four underground vaults (249,810 liter capacity). Water is supplied by tanker truck on an as-needed basis.

Colorado Highway 128 and Colorado Highway 93 provide access to the site. (Highway 93 intersects Highway 128 northwest of the site). The road from Highway 128 to the NWTC is paved. All other roads at the site are dirt or gravel. Improvements are planned to provide complete access by emergency vehicles and adequate access to test pads and facilities by NREL's industrial partners.

Denver West Office Park

NREL leases space in four buildings at the DWOP; these buildings house a large majority of NREL's staff members. Two of these buildings have shared occupancy with other tenants, while a third is shared with DOE staff. These facilities provide space for laboratory research, administration, and research support activities.

The risk is high, and is increasing with time, that DOE will have to spend capital dollars to repair or replace the ventilation system components in this leased building (DWOP Building 16).

The DWOP site includes 17,818 m² of leased space. Three buildings are used for administrative activities and one, Building 16, is used for laboratory research to support alternative fuels, transportation, industrial processes and resource assessment. While Building 16 ventilation remains adequate for the laboratory work done in the building, the ventilation system is nearing the end of its expected useful life. The risk is high, and is increasing with time, that DOE will have to spend capital dollars to repair or replace the ventilation system components in this leased building. Also, the ventilation system will not allow any more hoods to be added for expanded wet chemistry work. The building configuration allows for very little flexibility in changing laboratories to accommodate changing program priorities. Because it is a refurbished office building, there is no loading dock and only one elevator for all deliveries and passenger use, resulting in inefficient handling of gas cylinders and chemicals needed in the laboratories.

Because of the operational problems with Building 16, and the continuing concern regarding possible lease rate increases by the landlord, NREL has in the past conducted a survey of the west Denver area for other leasable laboratory space. The response was discouraging; in fact, NREL

found that other federal agencies are building new facilities in west Denver because of the unavailability of laboratory space and the high cost to retrofit office or warehouse space into laboratories (General Services Administration for the Environmental Protection Agency and U.S. Geological Survey).

In mid-FY 1999, the Building 16 lease ends, and renewal is expected to be difficult or impossible because of the diminishing amount of leasable office space available created by a local economic upswing.

Joyce Street Facility and 48th Street

The Joyce Street Facility (JSF) and the 48th Street facility are leased commercial spaces that provide temporary additional space for NREL's activities. JSF currently accommodates research experiments in several technologies and provides warehouse and storage space. The lease will be renewed in mid-1997. The 48th Street facility has been used for buildings research activities; its lease expires in May 1997 and will not be renewed. These facilities have no permanent employees.

Washington, D.C. Office

NREL leases space near DOE's Forrestal Building for NREL staff working closely with DOE and for use by NREL Golden staff visiting DOE in Washington. The Washington office supports about 22 staff members.

Managing Facilities Planning

To respond to DOE requests for better and more integrated facilities planning, EE established a Facilities Oversight Board (FOB) in 1991 consisting of senior managers from EE, the Golden Field Office (GO), and NREL. The FOB helps ensure that NREL's facilities and associated budget requests are appropriately prioritized for the laboratory's construction activities.

NREL has ... established several committees to analyze critical resource needs and ensure that consistent criteria are applied throughout the planning process.

NREL has since then also established several committees to analyze critical resource needs and ensure that consistent criteria are applied throughout the planning process: the Facilities Planning Task Force (FPTF), the Business Council (BC), and the Architectural Review Board (ARB). The FPTF, consisting of mid-level staff, helps identify NREL's facilities needs for the mid-term (1 to 5 years) and long-term (5 to 20 years) and recommends actions to meet those needs. The BC, consisting of senior NREL managers, provides direction, sets priorities, and acts on recommendations of the FPTF.

The ARB consists of the Site Operations Center construction and architectural representatives, selected representatives from R&D Centers, a GO representative, a consulting architect, a consulting landscape architect, and a community representative. The ARB reviews facilities and site

development plans and designs, and recommends actions to NREL management.

Together, the long-term human and facilities needs of the laboratory are carefully considered with respect to budgets, financial resources, and programmatic requirements.

Long-Term Facility Planning Goals, Strategies, and Assumptions

NREL's long-term goals for facility planning are as follows:

- Provide state-of-the-art laboratories for high quality research
- Maximize efficiency by consolidating operations as much as possible
- Minimize (hopefully eliminate) the use of leased space
- Sustain the functionality and utility of the government's existing assets at the STM and NWTC sites
- Meet or exceed all environment, safety, and health regulations; orders; and codes
- Offer flexibility to accommodate uncertainty in future growth
- Foster and support a cohesive identity, appropriate research atmosphere, excellent staff communications, and facilities that will attract high-quality research staff
- Be a good community neighbor

NREL's overall strategy is to move staff out of the existing leased space at the DWOP site into permanent facilities at the STM and NWTC sites.

To achieve these facility planning goals, NREL's overall strategy is to move staff out of the existing leased space at the DWOP site into permanent facilities at the STM and NWTC sites. NREL may acquire and maintain additional leased office space for short periods of time as necessary to relieve overcrowding and/or provide some flexibility.

At the STM site, NREL's strategy is to develop the site toward its land-use carrying capacity of 1650 people, while meeting the facility planning challenges outlined below. At the NWTC site, NREL's strategy is to continue developing the site as a satellite location for field testing and development activities that may be inappropriate for the residential areas near the STM site; current NWTC facilities have a capacity of about 80 people.

As an alternative site development strategy for the STM site, NREL and DOE have had preliminary discussions with the state of Colorado regarding the possible acquisition for future development of a small (12 ha) piece of undeveloped land adjacent to the STM site, which the state currently owns. DOE also has first right of refusal on land adjacent to the STM site that is currently used by the Colorado National Guard. This land could be used for research support activities.

NREL recognizes the importance of an architectural land use plan to guide the development of an area as visible and important to NREL as the STM site. Accordingly, NREL has, and will continue to, engage outside firms to develop architectural land use plans for the STM and the NWTC sites.

NREL expects to continue R&D activities across a broad spectrum of renewable and energy efficiency technologies, involving scientific and engineering disciplines similar to its current mission. NREL's traditional emphasis on basic and applied research continues to evolve to a more balanced emphasis on activities supporting the full breadth of the technology development cycle. This change implies that NREL may require more high-bay, engineering, and process development facilities. In addition, NREL will continue to require low-bay laboratories for both dry and wet activities for materials science, chemistry, and biology research. The emphasis on process development facilities is necessary for NREL to provide support to U.S. industry in the commercialization of renewable energy and related technologies as NREL increases its industrial partnering.

Long-Range Facility Challenges and Responses

Based on these assumptions, careful considerations of potential directions of NREL programs, and the existing conditions summarized previously, the major long-term challenges relating to R&D facilities requirements can be summarized as follows:

- Inadequate facilities for engineering, testing, and process development activities
 - The need to continue using leased facilities (DWOP Building 16) for laboratory research
 - Inadequate facilities to accommodate chemical and biological R&D
 - The lack of biocontainment laboratories for the advanced biotechnology research required in future biofuels research
 - The need to continue using leased facilities for research support
 - Obsolete telecommunications infrastructure
- NREL expects to continue R&D activities across a broad spectrum of renewable and energy efficiency technologies, involving scientific and engineering disciplines similar to its current mission.**

NREL plans to respond to the first challenge—inadequate facilities for engineering, testing, and process development activities— by adding specific small- and medium-sized facilities at the west end of the STM site and at the NWTC site over the next 5-10 years as needs arise.

NREL plans to respond to the next three R&D-related challenges—the need to continue using leased facilities for laboratory research, inadequate facilities to accommodate chemical and biological R&D, and lack of biocontainment laboratories—by a two-pronged approach. In the near-term, the response will be to renovate and expand the research laboratory space at the FTLB, in several phases.

This project is described further in the Five-Year Construction Program Requirements section, page 6-14. In the longer-term, the response will be to build one or two additional laboratory buildings. The future need for other laboratory buildings will continue to be reviewed.

NREL plans to respond to the next challenge—the need to continue using leased facilities for research support—with the construction of one major building, the Research Support Building (RSB). This new building will allow NREL to move out of leased facilities into a DOE-owned building. This project is described further in the Five-Year Construction Program Requirements section, page 6-14.

NREL plans to respond to the last challenge—obsolete telecommunications infrastructure—through significant upgrades to this infrastructure in the near future. This project is described further in the Five-Year Construction Program Requirements section, page 6-14.

Table 3, page 6-22, summarizes NREL's long-term construction program. It is presented in terms of the facility requirements described above and NREL's planned responses, organized around four distinct land-use areas (STM-West End, STM-East End, STM-Mesa Top, and NWTC).

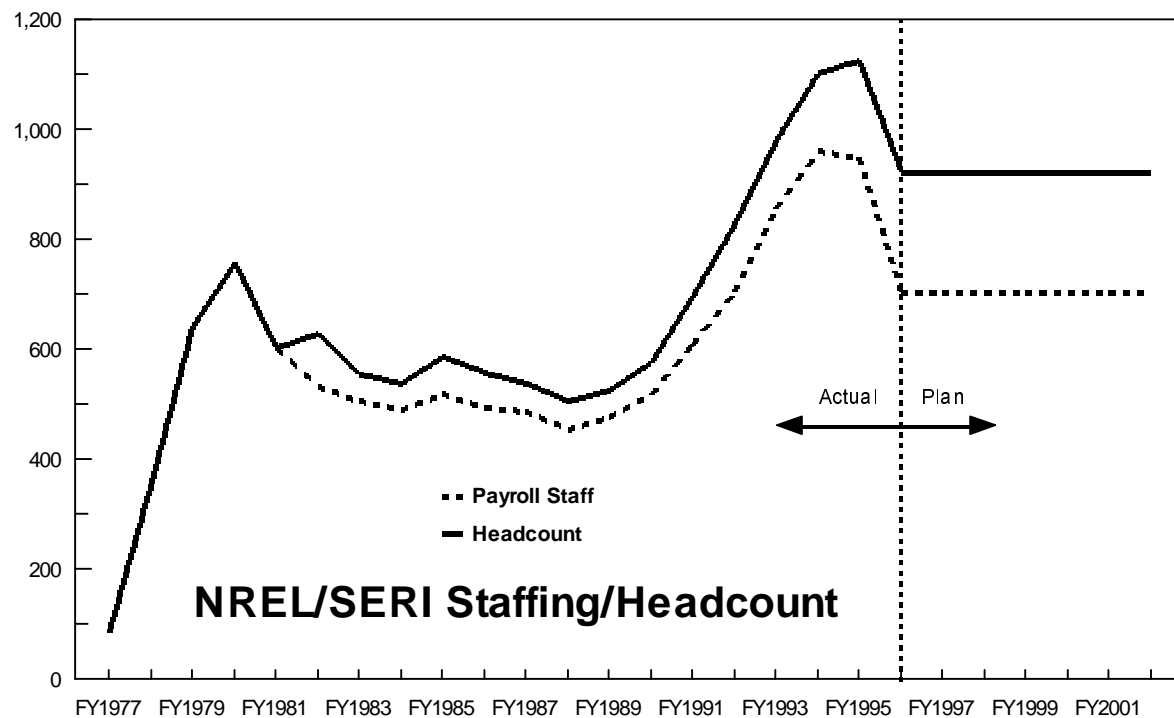
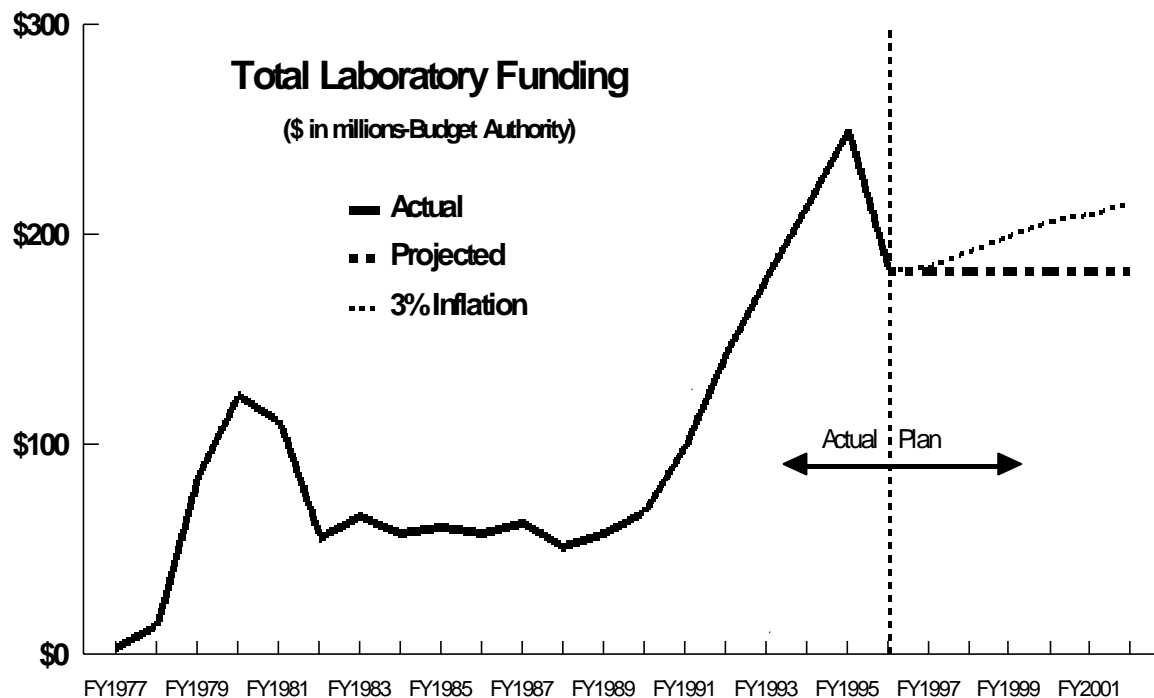
Five-Year Construction Program Goals and Assumptions

The goals for the five-year construction program are to provide facilities that will:

- Reconfigure facility capacity in response to budget and staffing reductions
- Implement NREL's long-term facility planning goals
- Meet the expected mission projections, with both a strong emphasis on near-term projections and a serious consideration of long-term projections
- Adhere to the architectural land use plans determined to be the best for NREL's two major sites
- Renovate and upgrade aging facilities to today's operational and safety standards
- Meet or exceed all DOE orders and directives, especially those pertaining to environment, safety, and health

The estimates for the next 5 years are based on careful consideration of the current administration's plans and policies and of individual programs and technology areas within DOE.

The most important assumption affecting NREL's facility requirements is the Laboratory's expected level of funding and staffing. As shown in the graphs below, real growth in funding for the Laboratory beyond FY 1997 is expected to be generally flat with 3% increase per year for inflation. Similarly, the current staff level is expected to hold steady for the foreseeable future. Assuming no significant change in subcontracting trends, staff growth is therefore expected to remain flat until substantial changes are experienced in funding levels.



Five-Year Construction Program Requirements

Specific projects during the next five years have been determined through careful consideration of the current administration's plans and policies and of individual programs and technology areas within DOE and NREL, in conjunction with analysis of the long-term facility planning challenges outlined on page 6-11, and consultation with the stakeholders described on page 6-9.

Table 2. NREL Five-Year Construction Plan
Estimated Funding Required for Each Fiscal Year

Project Name	Estimated Project Total Cost	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
Line-Item Construction Projects								
Field Test Laboratory Building Renovation and Expansion	\$ 6,500	\$ 1,500	\$ 2,800	\$ 2,200				
NREL Research Support Facility	\$ 0	(Assumes 3rd Party Financing)						
Data System Infrastructure	\$ 3,000				\$ 3,000			
Field Test Laboratory Building - Modification	\$ 5,500					\$ 5,500		
Warehouse	\$ 3,000						\$ 3,000	
Total Line-Item Construction	\$ 18,000	\$ 1,500	\$ 2,800	\$ 2,200	\$ 3,000	\$ 5,500	\$ 3,000	\$ 0
General Plant Projects								
STM Site Modifications	\$ 120	\$ 120						
NREL Infrastructure	\$ 200		\$ 200					
NREL Infrastructure	\$ 1,000			\$ 1,000				
Mesa-top Support Structure	\$ 700			\$ 700				
Thermochemical User Test Facility	\$ 1,950				\$ 1,950			
NREL Infrastructure	\$ 350				\$ 350			
NREL Infrastructure	\$ 700					\$ 700		
Total Request Anticipated for FY 2001	\$ 1,100						\$ 1,100	
Total Request Anticipated for FY 2002	\$ 3,100							\$ 3,100
Total General Plant Projects	\$ 9,220	\$ 120	\$ 200	\$ 1,700	\$ 2,300	\$ 700	\$ 1,100	\$ 3,100

The five-year construction program is given above in Table 2. While the entire construction program is important to NREL, only the cornerstones of the five-year construction program will be discussed at length here:

- FTLB Renovation and Expansion
- Research Support Building
- Data Systems Infrastructure
- Warehouse Facility

FTLB Renovation and Expansion Projects

NREL's construction program in the late 1980s and early 1990s assumed that the SERF, when built in FY 1993, would allow NREL to convert Building 16 back to office space. However, major expansion during FY 1993-FY 1995 in several new program areas created two facility challenges: first, program expansions required NREL to continue using Building 16 for R&D activities for the foreseeable future; second, even with Building 16, NREL had to conduct research in very crowded laboratories and hoods.

To respond to the two challenges created by these program expansions, in the early 1990s NREL requested funding for a new major laboratory R&D facility as the best option for NREL's future facility and laboratory development. These funding requests were not approved. In FY 1996, with new information about imminent funding reductions, NREL chose to delay its request for a new major laboratory R&D facility until a later date, and focus instead on renovating and expanding NREL's first laboratory building for chemistry and biology research, the FTLB, to respond to the laboratory's two facility challenges.

The funding reductions, and resulting staff reductions, in FY 1996 helped to relieve the severe overcrowding in NREL R&D facilities. However, the reductions did not resolve the problem of needing to use Building 16 for critical research activities in biofuels, chemicals, hydrogen, resource assessment, and transportation. To accomplish its mission for DOE, NREL still needs additional laboratory space in DOE-owned facilities.

The current FTLB Renovation and Expansion project is designed to get wet laboratory activities out of Building 16 by the time the lease expires in FY 1999. The project consists of three phases: \$1.5 million in FY 1996, \$2.8 million in FY 1997, and \$2.2 million in FY 1998. This project will reconfigure and upgrade the FTLB utilities to today's safe operating standards, and reconfigure and upgrade FTLB space utilization to accomplish five goals: upgrade and renovate existing building labs; safely segregate lab operations from support; increase building efficiency; add 920 m² of external lab support space; and add 1100 m² of mezzanine lab space internally. The completion of this current project is intended to allow the partial removal of laboratory activities, associated

offices, and support functions from Building 16. If the requested funding is received, the interim buildout of the FTLB is expected to be completed in FY 1999.

The FTLB Renovation and Expansion project will still leave key laboratory and research support activities in Building 16. An additional construction line item, the FTLB Modification project, is proposed for \$5.5 million for FY 2000. This Modification project will add dry laboratories, more high-bay space for anticipated process improvement activities, and offices to the FTLB by building out space and constructing an addition. This should allow for the complete evacuation of DWOP Building 16 by FY 2002. Without this FTLB Modification project, NREL will be forced to continue conducting research and support activities in leased office facilities.

NREL strongly recommends renovating and expanding the FTLB as the most cost-effective and efficient way for DOE to continue support to these important programs.

These two projects to improve and expand the FTLB (Renovation and Expansion Phases I, II, and III and the later Modification project) will provide important benefits:

- Reduce NREL's annual lease operating costs by more than \$1.3 million per year
- Allow NREL to vacate all wet and dry lab space currently in a leased office facility
- Consolidate operations to improve productivity and efficiency
- Reduce DOE's environmental and safety liability
- Align Laboratory capacity to reduced program mission requirements
- Provide upgraded and improved laboratories for important R&D in biomass conversion, including biofuels, biomass power, advanced industrial processing technologies, hydrogen, resource assessment, and transportation.

NREL strongly recommends renovating and expanding the FTLB as the most cost-effective and efficient way for DOE to continue support to these important programs.

Research Support Building

NREL's support functions, as well as wet and dry laboratory activities, have been done in leased office space since the laboratory opened. The majority of NREL staff currently reside in the DWOP complex which is physically separated from the STM site by I-70 at a distance of 2.7 km. This not only increases costs due to commute times of staff members, but unduly complicates voice and data communications systems by having to use and integrate commercial carriers in addition to NREL's own internal systems.

The proposed Research Support Building will allow NREL to reduce operating costs by getting out of expensive leased space.

The proposed multi-function Research Support Building (RSB) will add space for dry laboratories, offices, and laboratory support functions. Approximately 18,600 m², the RSB would house about 600 staff. This type of facility would bring several very important benefits:

- allow NREL to terminate four building leases, lowering the government's environmental and economic risks
- reduce operating costs by getting out of expensive leased space
- consolidate and co-locate administrative and laboratory operations

Studies done in the early 1990s showed significant economic benefits for DOE to build its own support building for NREL, rather than pay expensive lease costs. Construction funding has not been approved, however. DOE and NREL are investigating the possibility of soliciting private sector financing of the RSB under a build-to-suit arrangement. NREL would subsequently lease such a facility with the option to purchase it at a later date. The financial risk would thus be born by the private sector.

Data Systems Infrastructure

Modern and efficient communications and data transfer systems are essential to maintaining the integrity, viability, and excellence of NREL's research and development activities in support of its mission. NREL's communications and data transfer systems are outdated and inefficient, and difficult to maintain as additional facilities have been added during the 1990s. The Data Systems Infrastructure will enable NREL to expand and enhance its data-handling performance in the future.

This project will provide state-of-the-art information and data transfer systems for the STM site including a fiber-optic-based truck, head end, and building-specific data server and controls equipment. Some buried conduit infrastructure was installed between the major laboratory buildings during the design and construction of the STM Infrastructure, Phase I FY 1995 project, in anticipation of this requested Data Systems Infrastructure project.

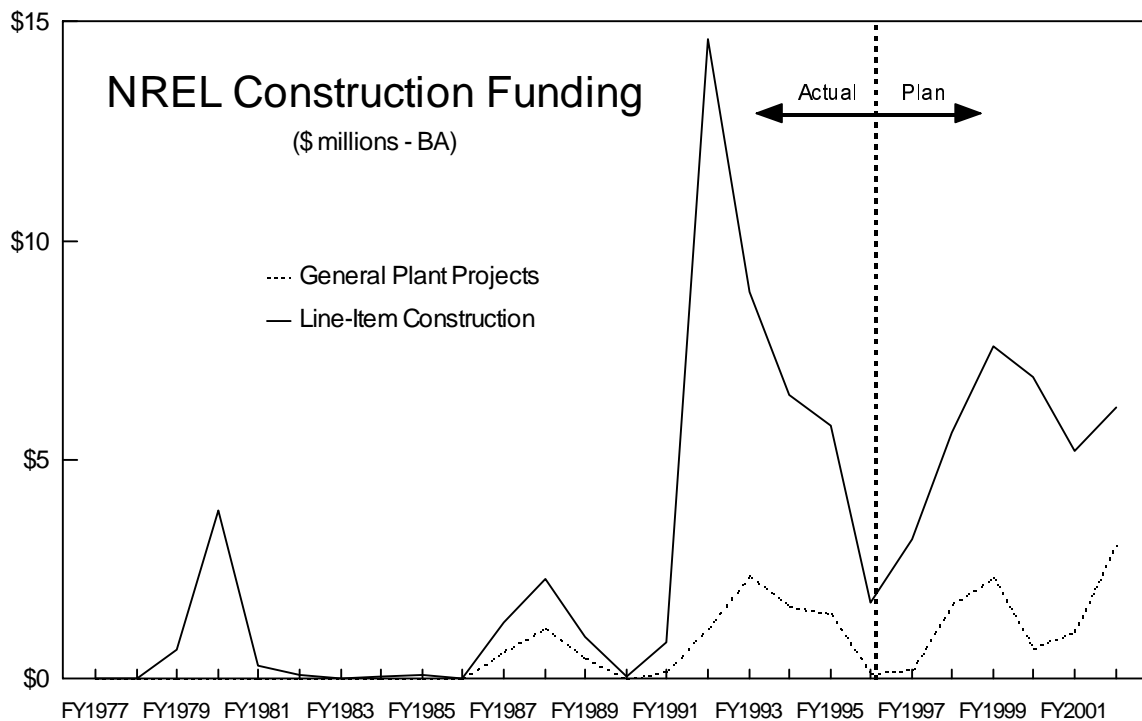
Warehouse Facility

DOE currently owns less than 929 m² of permanent general storage/warehousing space for NREL's use. NREL has been leasing an additional 5203 m² of general warehouse space for the past five years at the Joyce Street Facility, and is preparing to lease the equivalent amount of space for up to an additional five-year term. Following the general premise of its strategy to locate all of NREL's functions on DOE-owned land and reduce the operating expenses associated with the leasing of facilities, NREL is proposing to construct a general storage/warehouse facility (4,645 m²) at one of its permanent sites (to be determined). The plan calls for the general warehouse facility to be constructed by FY 2002 so as to coincide with the end of the lease of the warehouse. Total cost, if funded in FY 2001, would be \$3.0 million.

General Plant Projects

NREL is using its General Plant Projects allocation for construction projects of a general nature that do not exceed \$2.0 million in total cost—for example, the Shipping and Receiving Facility. The laboratory is also using these funds to make general infrastructure or physical plant upgrades and renovations, and to make improvements to the STM site. The graph on the next page shows historical construction funding, both for general plant projects and for line-item construction. The large peak in FY 1992 construction line item funding was for the SERF.

NREL's improved planning processes are enabling the laboratory to make better and more accurate use of the types of funds available by establishing both programmatic and operational priorities. Improved understanding of planning processes allows NREL to take advantage of the flexibility in the DOE funding system to acquire the necessary facilities and make needed infrastructure improvements to respond to evolving priorities.



Future General-Purpose Research Facilities

One of NREL's unique strengths is in the thermochemical conversion of biomass. This strength is fundamental to several programs, including much of NREL's R&D work in industrial processing and pollution prevention, biobased materials, and hydrogen.

Bench-scale and small pilot-scale R&D in thermochemical conversion is currently done in the FTLB. However, some of the required work cannot be done in that building because of the need to use higher volumes of organic solvents at higher pressures and temperatures than that building can accommodate. Current work is done at a subcontractor facility.

Best engineering practices require a separate building designed specifically to handle the higher risk implied by these conditions. NREL's STM site plan includes space at the far west end of the STM site for this type of facility.

Future Utilities and Communications

At the STM site, NREL plans to continue to develop the integrated electrical and communications network. The existing loop system can accommodate a future building at the far west end of the STM site and can be expanded for future buildings at the northeast end of the STM site. As the Denver West Area grows and PSCo expands the electrical distribution system in the area, NREL will pursue obtaining a second utility feeder (backup) and install the appropriate high voltage switchgear and automatic transfer switching to transfer power to a second power source if the primary power source is interrupted. NREL will continue to develop the electric power monitoring and recording for each building. The laboratory will be responsible for maintaining the equipment.

Consolidated Mutual Water Company has recently upgraded its water pump station downstream of the STM site (to the east), thus assuring the ability to maintain pressure at a sufficient flow rate to supply water to the site. An additional sewer line may need to be installed parallel to the existing line before the RSB is constructed, depending on the final selection of the location site.

NREL envisions that as many as 25 people may be working at the STM mesa top facilities during the planning period. NREL plans to add sanitary facilities and improve utilities and communications. The 13.2 KV distribution system at the Mesa Top has recently been reconfigured to accommodate the addition of the Geothermal Energy Conversion (GEC) facility that will be installed at the north end of the mesa top in the near future. A 13.2 KV feeder will be extended to this facility location and a transformer will be installed to accommodate the GEC program electrical needs.

At the NWTC, NREL will be upgrading the PSCo site utility feeder to handle the program requirements. This upgrade is expected to be complete in FY 1997. The current site utility feeder will not handle the anticipated future electrical requirements. As the electrical load increases the

main switchgear will need to be evaluated. The current main switchgear was installed at the time the NWTC site was initially developed. This equipment is now obsolete and spare parts are becoming difficult to obtain. The turbine distribution loop will be evaluated with respect to private sector power system considerations to make sure that the turbine system simulates the environment that the wind turbines would be installed in at the private sector level and to provide the needed safety to the R&D operation. Recent test site upgrades include concrete foundations, the upgrade of underground utilities, and data sheds. NREL has evaluated the most economic option for both near- and long-term water supply to the site for domestic and fire protection uses. As a result, NREL will continue to haul water by tanker truck and fill on-site holding tanks, as required.

At the STM site, the long-term communications plan includes the provision of fiber-optic and copper cables between buildings and the use of local area networks within buildings. Fiber-optic cable for data communications and copper cable for voice, fire alarm, and security service will be installed as part of the overall plan for an integrated electrical and communications network. Communications cable installations will follow the same distribution route, where practical, as the electrical distribution system, linking the main facility areas together.

NREL plans to continue to provide service between the DWOP and the STM sites using U S West Communications. Communications with the STM site, the NWTC site, and JSF will be provided by leasing service through U S West Communications.

Future Transportation

At the STM site, Denver West Parkway was extended to Quaker Street in FY 1994. A controlled entrance for emergency vehicles and NREL staff restricts access to the site from the west. The public has pedestrian access to the mesa top, continuing our open space policy with the community. All public vehicle access, including shipping and receiving, will be provided through the east entrance to the site. NREL is and plans to continue to upgrade the roads, parking, and sidewalks as part of its site infrastructure projects. Also, NREL will continue to review the existing two-lane Denver West Parkway to decide whether it needs to be widened, and continue working with the state on access to the mesa top.

At the NWTC, NREL plans to make site improvements, including approximately 1.0 km of road upgrades.

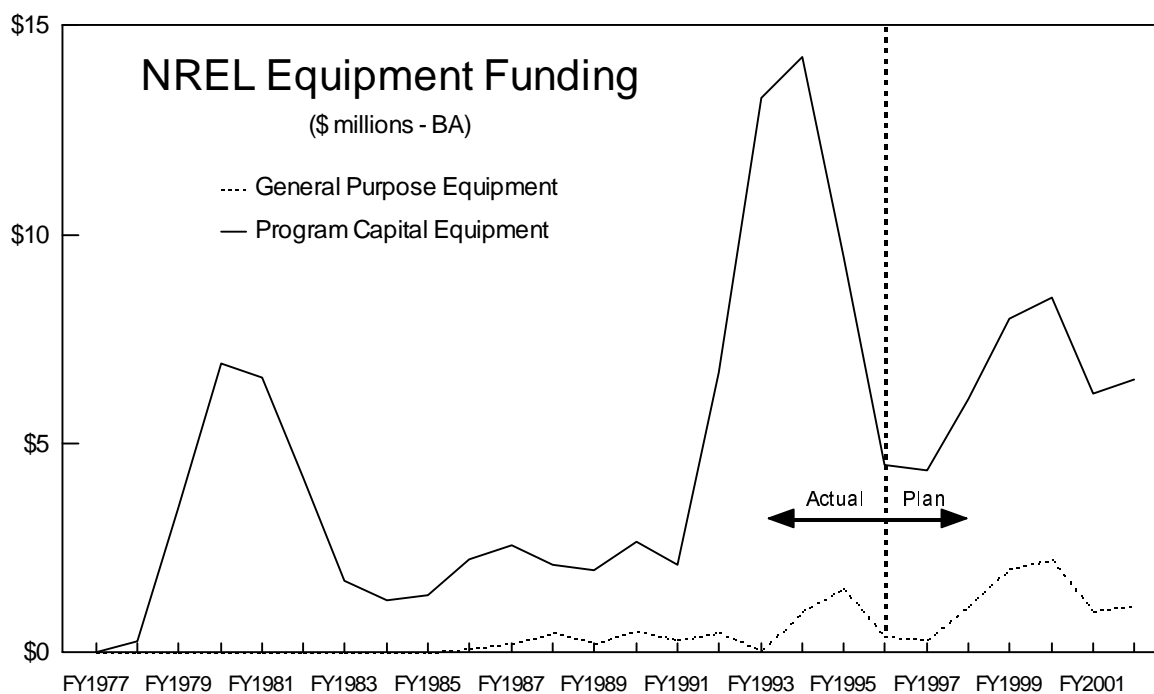
General Purpose Equipment

Modern research and laboratory equipment is vital to fulfilling the missions of NREL and DOE. The graph on the next page shows the laboratory's history for general purpose equipment (GPE) and program capital equipment (PCE). The large peak around FY 1993

Modern research and laboratory equipment is vital to fulfilling the missions of NREL and DOE.

in PCE was for new research equipment in the SERF.

GPE includes such institutional capital equipment items as computers, photocopiers, and communications equipment, ES&H monitoring equipment, security systems, maintenance equipment, and general laboratory equipment such as metrology instrumentation. NREL's needs during the planning period require replacement and purchase of metrology equipment, high-speed copiers, administrative and shared scientific computing equipment, communications systems equipment, and facilities equipment.



PCE includes equipment purchased for single-program benefit. Equipment purchased for shared-program use falls under the GPE category. Examples of PCE include major laboratory instrumentation (i.e. electron microscopes, mass spectrometers, and deposition equipment). As NREL has broadened and expanded its research, development, and commercialization activities, and will continue to do so during the planning period, state-of-the-art equipment is critical. Immediate needs include equipment for upgrading computer networks and telecommunications (related to the Data Systems Infrastructure project described on p. 6-17) Other needs include copiers, site maintenance and security equipment, and general purpose scientific equipment such as common analyzers.

EE recognizes the importance of modern equipment to meet both in-house and research partner needs and is working closely with NREL to secure these vital resources in a timely manner.

Table 3. NREL Site Development Master Plan: Long-Range Construction Program				
Facility Requirements — Need and Responses				
I. Expand capability for engineering, testing, and process development: STM-West buildout				
A.Buildings (Size in net m ²)		Size	Funding Status	Completion (FY)
Research facilities	1. Field Test Laboratory Building renovations and expansion	410 2,000 900	\$1.5 million in FY 1996 received; \$2.8 million in FY 1997 approved; \$2.2 million in FY 1998 requested: to modify existing high-bay space and add mid-bay and office space	1997-1999
	2. Alternative Fuels Users Facility Add'n	929	\$0.8 million in FY 1998 anticipated	1999
	3. Field Test Laboratory Building Modification	2,640	\$5.5 million in FY 2000 anticipated	2002
	4. To be determined (TBD) - Small Lab	900	\$1.95 million in FY 2002 anticipated	2002 - 2003
	5. To be determined (TBD) - Small Lab	900	\$1.95 million in FY 2003 anticipated	2004 - 2005
	6. To be determined (TBD) - Small Lab	900	\$1.95 million in FY 2006 anticipated	2007 - 2008
Flammable-hazard facilities	7. Thermochemical User Test Facility	950	\$1.95 million in FY 1999 requested	2000 - 2001
Support facilities	8. Shipping and Receiving Building	1,282	\$1.45 million in FY 1995 received	1997
B.Infrastructure				
Infrastructure	1. Utilities (water, sewer, electricity, natural gas), communications, roads, water management, and landscaping for entire STM site		STM-wide projects: \$2.75 million in FY 1995 received \$0.12 million in FY 1996 received \$0.20 million in FY 1997 received \$1.00 million in FY 1998 requested \$0.35 million in FY 1999 anticipated \$0.70 million in FY 2000 anticipated \$1.10 million in FY 2001 anticipated \$1.15 million in FY 2002 anticipated	1996-2003
	2. Data System Infrastructure		\$3.0 million in FY 1999 anticipated	2001
II. Expand capability of laboratory research and administration: STM-East buildout				
A.Buildings (Size in net m ²)		Size		
Research facilities	1. Research Facility	12,236	\$57 million in FY 2005 anticipated	2006 - 2007
	2. Research Facility	12,236	\$63 million in FY 2012 anticipated	2014 - 2016
Support facility	3. Research Support Building	18,600	assume third-party financing	2001 - 2002
III. Improve STM mesa-top facilities				
A.Buildings (Size in net m ²)		Size		
Research facility	1. Geothermal Energy Conversion Facility	232	\$0.55 million in FY 1996 received	1997
Support facility	2. STM Mesa Top Support Structure	204	\$0.70 million in FY 1998 requested	2000
IV. Expand capability for wind energy research and testing: NWTC Development				
A.Buildings (Size in net m ²)		Size		
Research facility	1. Dynamometer & Spin Test Facility	387	\$2.4 million in FY 1997 received	1998
Support facility	2. General Storage/Warehouse Building	4,645	\$3.0 million in FY 2001 anticipated	2002
B. Infrastructure				

Table 3. NREL Site Development Master Plan: Long-Range Construction Program Facility Requirements — Need and Responses			
Infrastructure	1. Road paving, electrical upgrade	\$0.5 million in FY 1997 received	1997

Information Technologies

The development of information technologies (IT) management at NREL is four-fold: delivery of relevant technology, understanding business issues, alignment of IT strategy with NREL strategy and satisfying our internal clients and external customers.

The Information Services Center (IS) utilizes a management approach which recognizes differences in both NREL Client groups and IS product and services. This new management approach separates delivery of IT solutions from content and actually involves moving all content product and services to other parts of NREL. The new Center is responsible for managing NREL's IT capability and providing the leadership to ensure that NREL's IT investments are integrated to NREL's mission and strengthen NREL's critical business strategies. The approach includes providing and maintaining a well-designed, cost-effective IT infrastructure and partnering with clients to design, evaluate and deliver quality information systems and services.

During the planning period, IS will be undertaking a major information architecture project. This initiative will enable the IS Planning and Assessment Team to plan for and develop the growth of the installed base within a framework of moving toward emerging technologies and reducing operating costs through reduction in infrastructure complexity.

Development of IT management is four-fold: delivery of relevant technology, understanding business issues, alignment of IT strategy with NREL strategy and satisfying our internal clients and external customers.

The intended result of this initiative will be a clear understanding of our business processes, alignment of technology needs to business needs, architectural guidelines, process of evolving standards, and evaluation of current and future initiatives.

It is expected that through the understanding of our business processes we will establish a plan for the future direction of IT at NREL in such positive areas as: upgrading our existing business systems, supporting the development and deployment of additional Internet and Intranet applications, telecommuting and collaborative workflow/workgroup technologies.